4th World Congress on Agroforestry

20-22 May 2019
Montpellier, France

Book of Abstracts

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L17.P.29

Simple individual based model to unravel complex agroforestry systems, case of banana and cacao systems in Talamanca

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To improve the management of complex agroforestry systems, it is crucial to understand how plants interact. However, in such complex systems, methods to disentangling plant interactions are lacking.The aim of this study was to address the questions: how the spatial structure of the plant community affects yields? We present an original individual-based statistical approach that allows the assessment of interactions in highly complex agroforestry systems. We applied our methodology in 19 plots in farmer fields in Talamanca, Costa Rica to analyse the effect of the structure of the plant community in the neighborhood of each individual cacao tree and banana plant on their yield. We found that the distance at which other trees alters the yield of banana or cacao was greater for fruit or wood trees than cacao trees or banana plants. Interestingly, higher strata trees had a smaller effect than lower strata trees, suggesting that moderate densities of tall trees could be compatible with high banana and cacao production. On an applied perspective, our results suggest that productivity could be maximized by a reasonably number of plant species, and then we proposed new direction to organize fields in order to maximize the production of cash crops while providing supplementary income for farmers and ecosystem services. The complete linear model predicted about 60% of the variance of the average response of the potential yield to the neighboring plant assemblage.

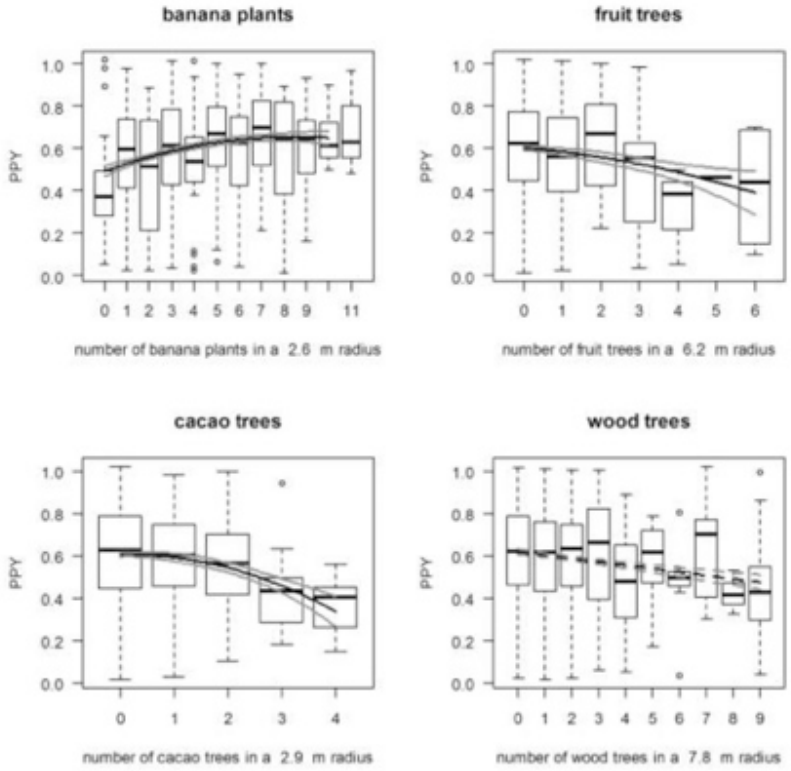

Figure 1. Model fit of the predictions of the proportion of the cacao potential yield (PPY) according to the number of banana plants in a 3.9 m radius, fruit trees in a 3.9 m radius, cacao trees in a 5.5 m radius, and wood trees in a 5.1 m radius. The black lines show the mean responses, and the grey lines show the standard errors predicted by the 'lmer' (dashed-lines show non-significant relations).